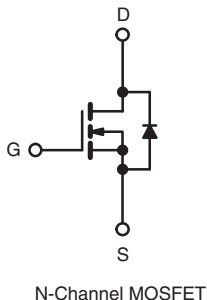
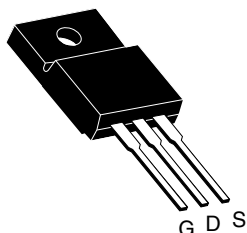


## D Series Power MOSFET

### PRODUCT SUMMARY

$V_{DS}$ (V) at $T_J$ max.	450	
$R_{DS(on)}$ max. at 25 °C ( $\Omega$ )	$V_{GS} = 10\text{ V}$	0.6
$Q_g$ max. (nC)	30	
$Q_{gs}$ (nC)	4	
$Q_{gd}$ (nC)	7	
Configuration	Single	

### TO-220 FULLPAK



### FEATURES

- Optimal Design
  - Low Area Specific On-Resistance
  - Low Input Capacitance ( $C_{iss}$ )
  - Reduced Capacitive Switching Losses
  - High Body Diode Ruggedness
  - Avalanche Energy Rated (UIS)
- Optimal Efficiency and Operation
  - Low Cost
  - Simple Gate Drive Circuitry
  - Low Figure-of-Merit (FOM):  $R_{on} \times Q_g$
  - Fast Switching
- Compliant to RoHS Directive 2011/65/EU

### Note

\* Pb containing terminations are not RoHS compliant, exemptions may apply

### APPLICATIONS

- Consumer Electronics
  - Displays (LCD or Plasma TV)
- Server and Telecom Power Supplies
  - SMPS
- Industrial
  - Welding
  - Induction Heating
  - Motor Drives
- Battery Chargers



**RoHS\***  
COMPLIANT

### ORDERING INFORMATION

Package	TO-220 FULLPAK
Lead (Pb)-free	SiHF10N40D-E3

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ °C}$ , unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	$V_{DS}$	400	V
Gate-Source Voltage	$V_{GS}$	$\pm 30$	
Gate-Source Voltage AC ( $f > 1\text{ Hz}$ )		30	
Continuous Drain Current ( $T_J = 150\text{ °C}$ ) <sup>e</sup>	$V_{GS}$ at 10 V	$T_C = 25\text{ °C}$	A
		$T_C = 100\text{ °C}$	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	23	
Linear Derating Factor		0.26	W/°C
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$	194	mJ
Maximum Power Dissipation	$P_D$	33	W
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to + 150	°C
Drain-Source Voltage Slope	$dV/dt$	$T_J = 125\text{ °C}$	V/ns
Reverse Diode $dV/dt$ <sup>d</sup>			
Soldering Recommendations (Peak Temperature)	for 10 s	300°	°C


### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ °C}$ ,  $L = 2.3\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 13\text{ A}$ .
- 1.6 mm from case.
- $I_{SD} \leq I_D$ , starting  $T_J = 25\text{ °C}$ .
- Limited by maximum junction temperature.

**THERMAL RESISTANCE RATINGS**

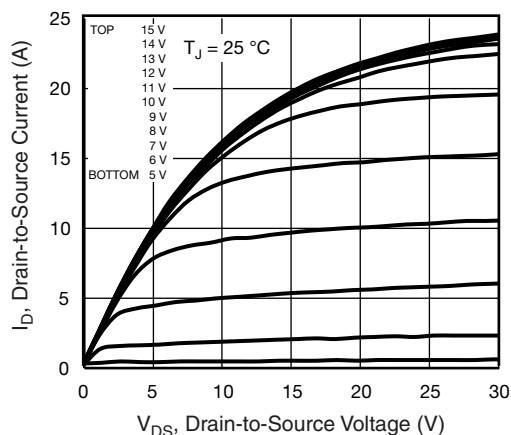
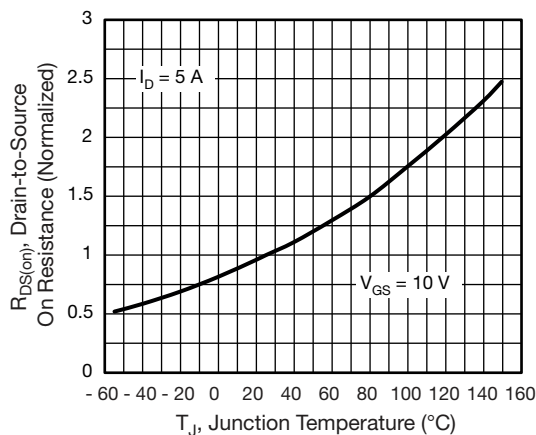
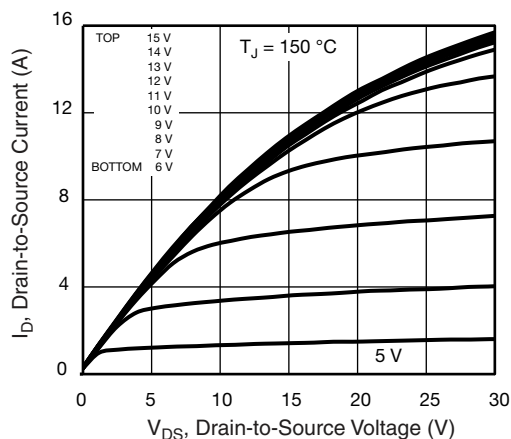
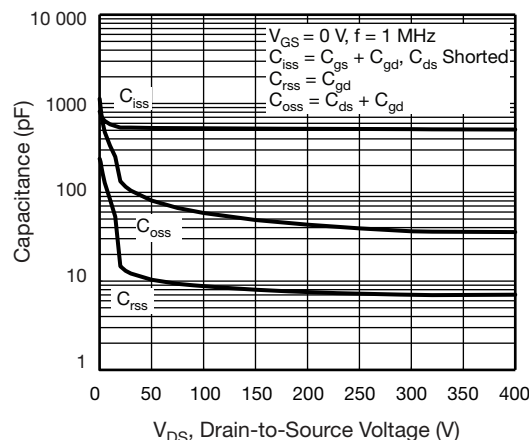
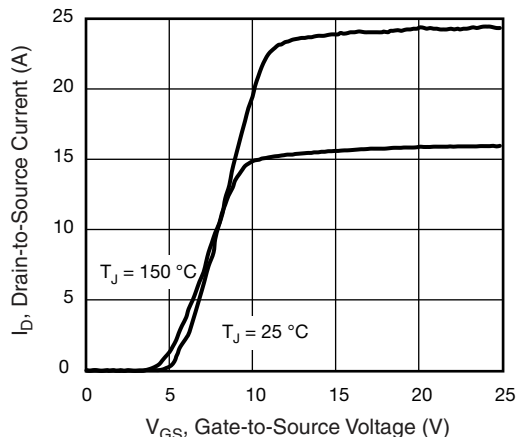
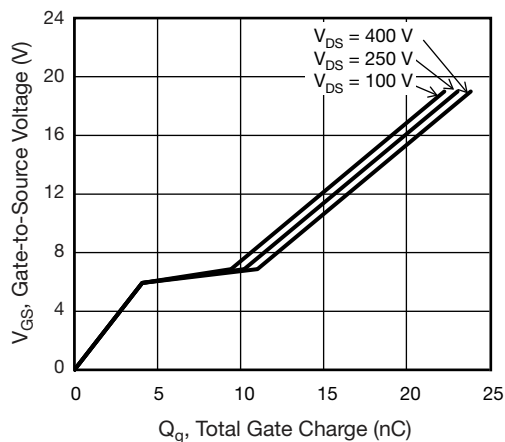
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	65	°C/W
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	3.8	

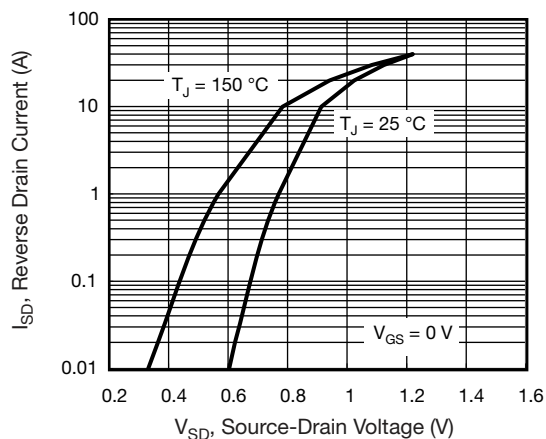
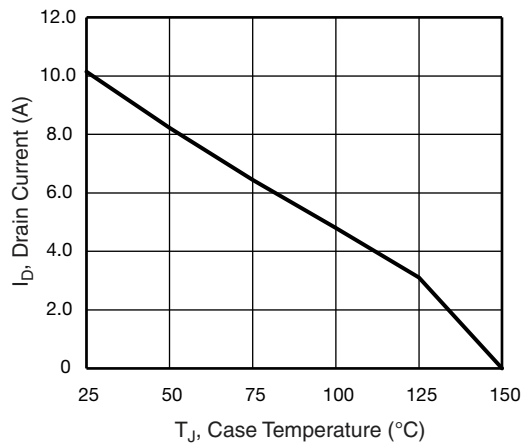
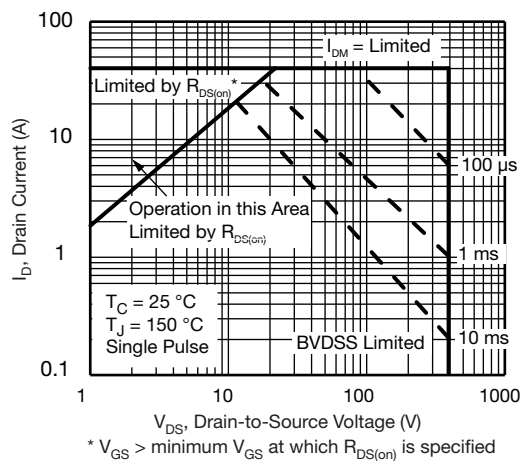
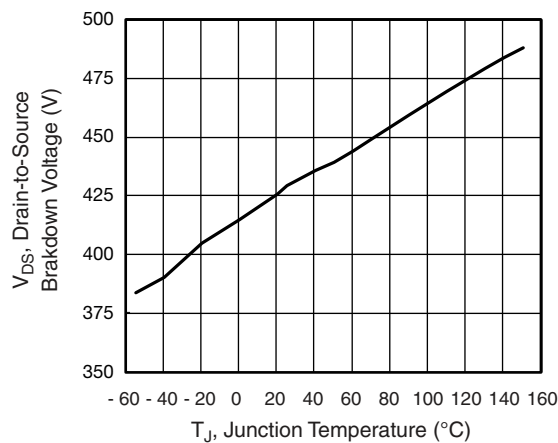
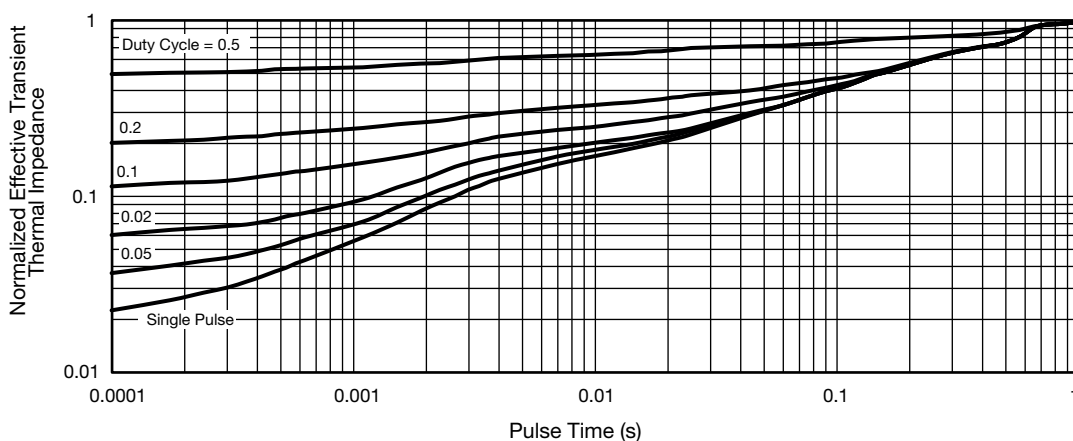
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

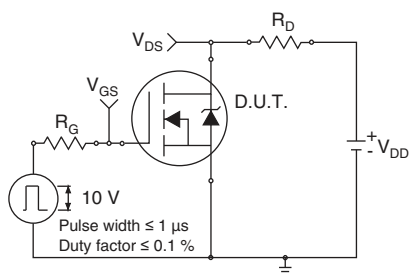
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA		400	-	-	V
V <sub>DS</sub> Temperature Coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	Reference to 25 °C, I <sub>D</sub> = 250 μA		-	0.53	-	V/°C
Gate-Source Threshold Voltage (N)	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA		3	-	5	V
Gate-Source Leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 30 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V		-	-	1	μA
		V <sub>DS</sub> = 320 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C		-	-	10	
Drain-Source On-State Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V	I <sub>D</sub> = 5 A	-	0.5	0.6	Ω
Forward Transconductance	g <sub>fs</sub>	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 5 A		-	2.7	-	S
Dynamic							
Input Capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 100 V, f = 1 MHz		-	526	-	pF
Output Capacitance	C <sub>oss</sub>			-	59	-	
Reverse Transfer Capacitance	C <sub>rss</sub>			-	9	-	
Effective output capacitance, energy related <sup>a</sup>	C <sub>o(er)</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 0 V to 320 V		-	66	-	pF
Effective output capacitance, time related <sup>b</sup>	C <sub>o(tr)</sub>			-	84	-	
Total Gate Charge	Q <sub>g</sub>	V <sub>GS</sub> = 10 V	I <sub>D</sub> = 5 A, V <sub>DS</sub> = 320 V	-	15	30	nC
Gate-Source Charge	Q <sub>gs</sub>			-	4	-	
Gate-Drain Charge	Q <sub>gd</sub>			-	7	-	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 10 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω		-	12	24	ns
Rise Time	t <sub>r</sub>			-	18	36	
Turn-Off Delay Time	t <sub>d(off)</sub>			-	18	36	
Fall Time	t <sub>f</sub>			-	14	28	
Gate Input Resistance	R <sub>g</sub>	f = 1 MHz, open drain		-	1.8	-	Ω
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	10	A
Pulsed Diode Forward Current	I <sub>SM</sub>			-	-	40	
Diode Forward Voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = 5 A, V <sub>GS</sub> = 0 V		-	-	1.2	V
Reverse Recovery Time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 5 A, dI/dt = 100 A/μs, V <sub>R</sub> = 25 V		-	230	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>			-	1.6	-	μC
Reverse Recovery Current	I <sub>RRM</sub>			-	14	-	A

**Notes**

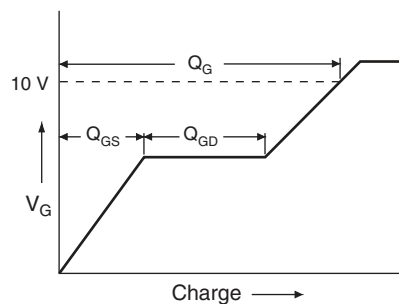
- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .  
b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .

**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

**Fig. 1 - Typical Output Characteristics**

**Fig. 4 - Normalized On-Resistance vs. Temperature**

**Fig. 2 - Typical Output Characteristics**

**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

**Fig. 3 - Typical Transfer Characteristics**

**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

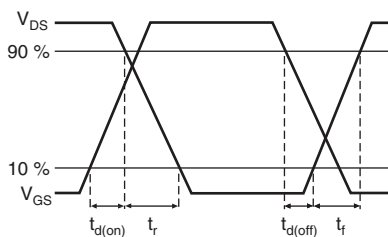

**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

**Fig. 9 - Maximum Drain Current vs. Case Temperature**

**Fig. 8 - Maximum Safe Operating Area**

**Fig. 10 - Temperature vs. Drain-to-Source Voltage**

**Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case**



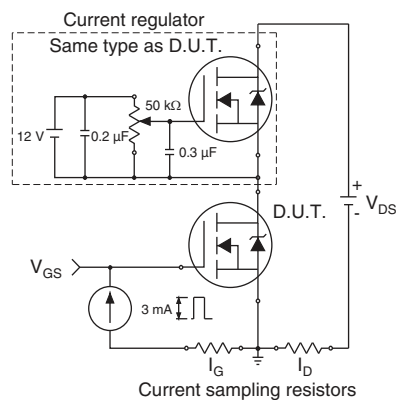
**Fig. 12 - Switching Time Test Circuit**



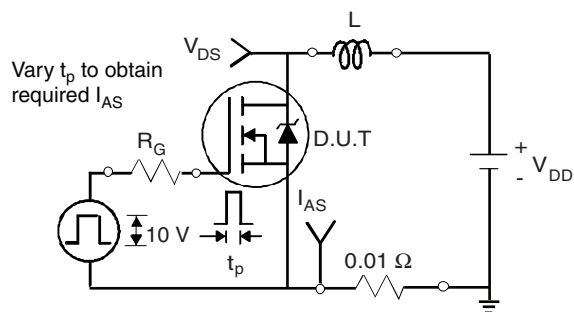
**Fig. 16 - Basic Gate Charge Waveform**



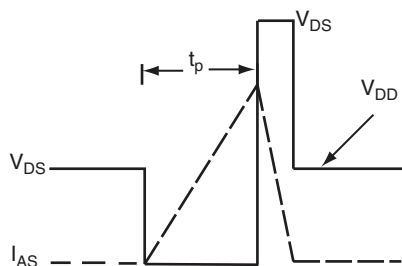
**Fig. 13 - Switching Time Waveforms**



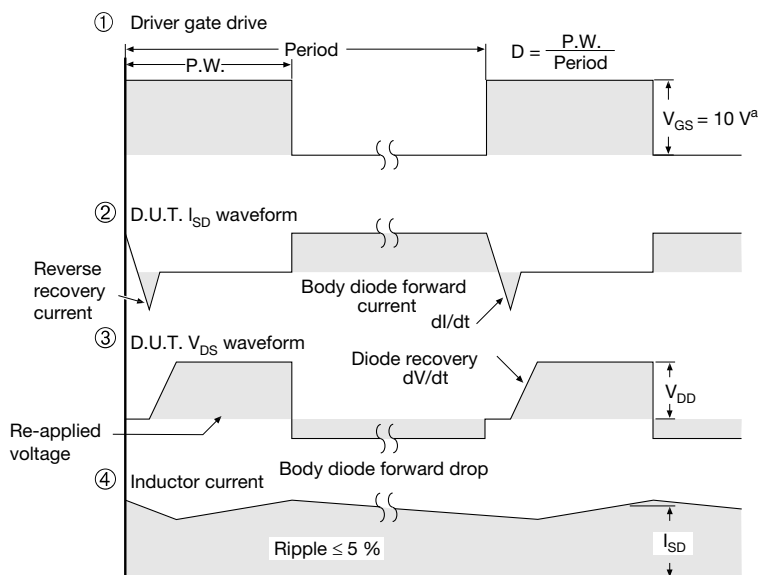
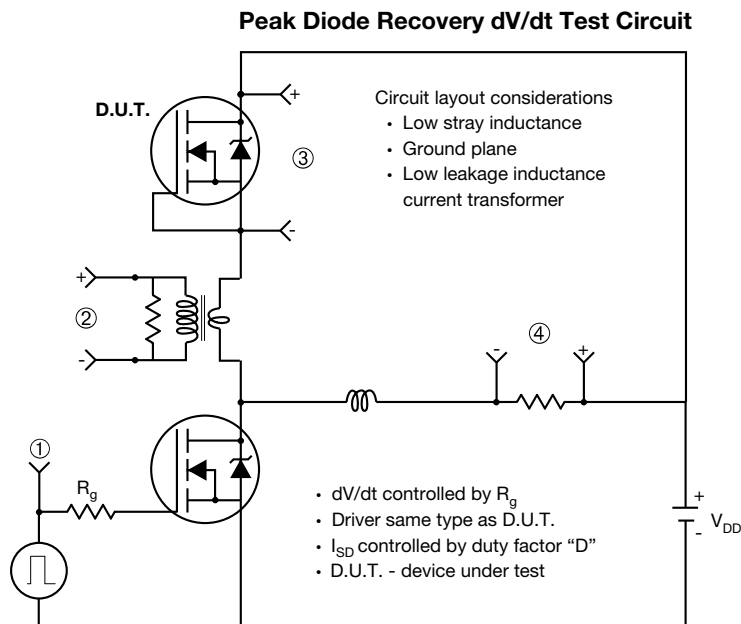
**Fig. 17 - Gate Charge Test Circuit**



**Fig. 14 - Unclamped Inductive Test Circuit**



**Fig. 15 - Unclamped Inductive Waveforms**

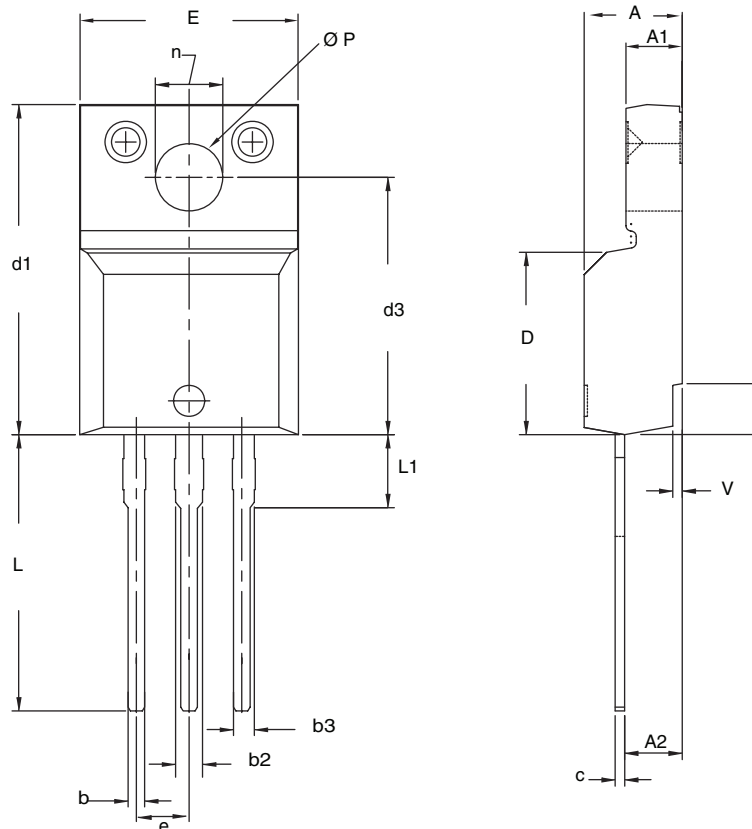

**Note**

a.  $V_{GS} = 5 V$  for logic level devices

**Fig. 18 - For N-Channel**

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## TO-220 FULLPAK (HIGH VOLTAGE)



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.570	4.830	0.180	0.190
A1	2.570	2.830	0.101	0.111
A2	2.510	2.850	0.099	0.112
b	0.622	0.890	0.024	0.035
b2	1.229	1.400	0.048	0.055
b3	1.229	1.400	0.048	0.055
c	0.440	0.629	0.017	0.025
D	8.650	9.800	0.341	0.386
d1	15.88	16.120	0.622	0.635
d3	12.300	12.920	0.484	0.509
E	10.360	10.630	0.408	0.419
e	2.54 BSC		0.100 BSC	
L	13.200	13.730	0.520	0.541
L1	3.100	3.500	0.122	0.138
n	6.050	6.150	0.238	0.242
Ø P	3.050	3.450	0.120	0.136
u	2.400	2.500	0.094	0.098
v	0.400	0.500	0.016	0.020

ECN: X09-0126-Rev. B, 26-Oct-09  
DWG: 5972

### Notes

1. To be used only for process drawing.
2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads.
3. All critical dimensions should C meet  $C_{pk} > 1.33$ .
4. All dimensions include burrs and plating thickness.
5. No chipping or package damage.



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